SNR Science

– from my personal point of view –

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SNR Science

- Supernove and supernova remnants are

  main suppliers of { energy, / heavy elements, / high energy particles (cosmic rays) }

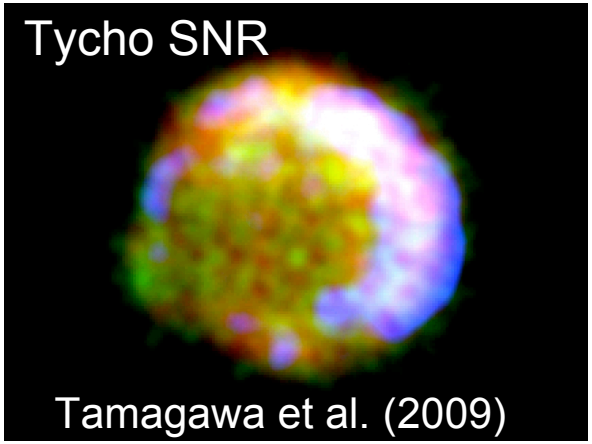
  in galaxies.

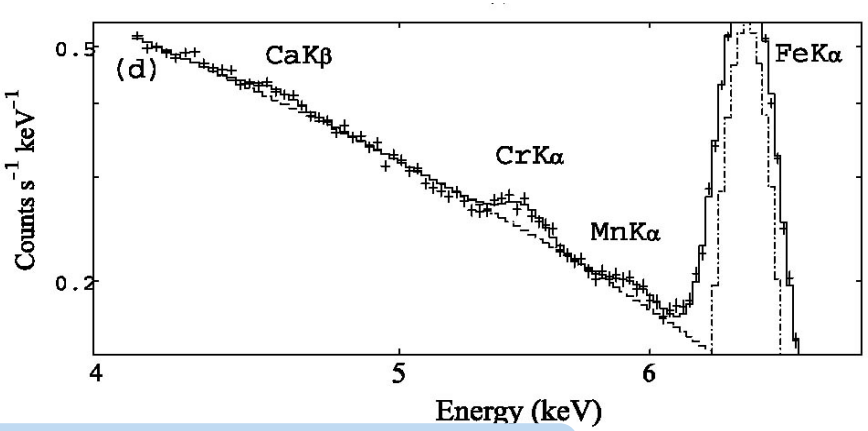
- We want to understand physics of supernova explosions and supernova remnants.
- We should know
  - nucleosynthesis in stars and SNe
  - process of supernova explosion
  - mechanism of particle acceleration
  - …

SNR Science

1. Nucleosynthesis and Process of SNe

- Measurements of emission lines in the plasma gas of young SNRs
  - Electron/ion/ionization temp. –> Physical condition
  - Metal abundance –> Progenitors, Nucleosynthesis
    - Suzaku detected Cr and Mn lines from Tycho's SNR and N103B (Tamagawa et al. 2009).
  - 3D structure of SNRs –> How they explode/expand.
    - expanding velocity, metal distribution, …



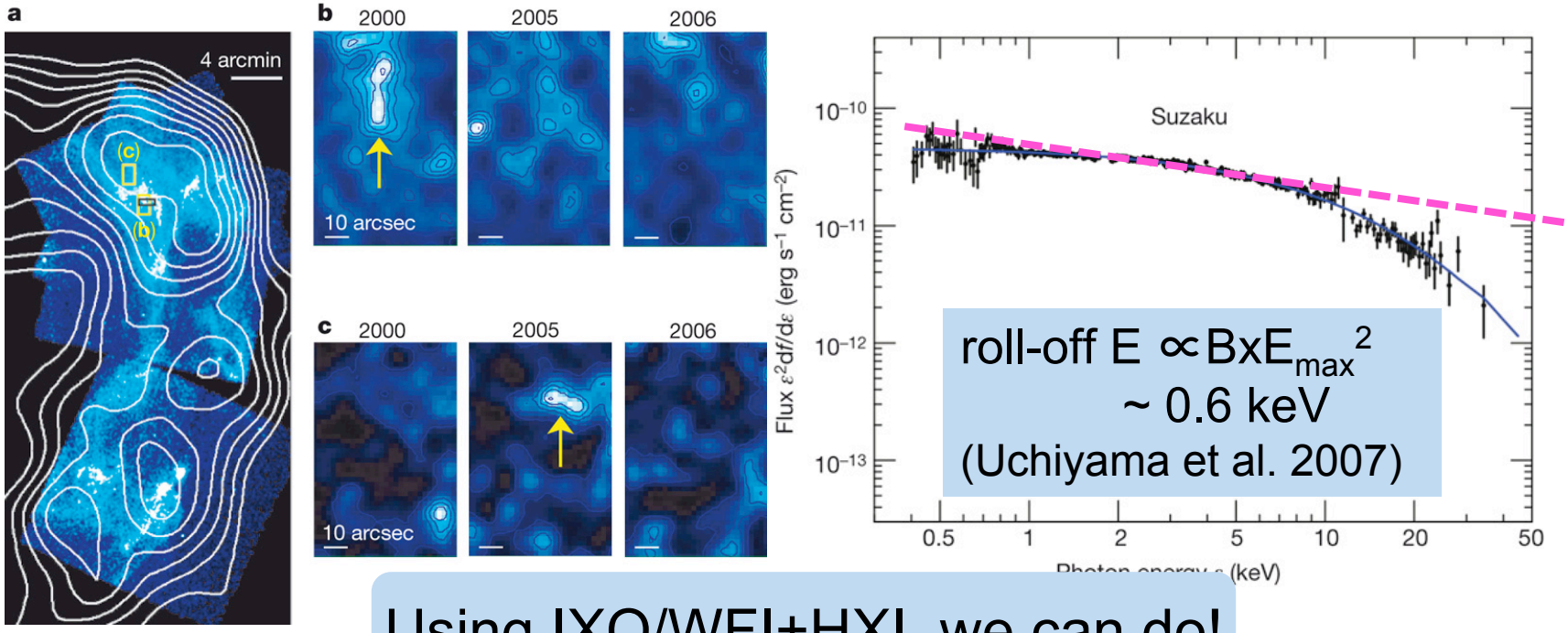


Using IXO/XMS, we can do!

SNR Science

2. Particle Acceleration at the SNR Shells

- Observations of images and spectra of the synchrotron X-ray emission from SNR shells
  - Location and structure of the non-thermal emission
  - Time variation of the intensity and spectral shape of the non-thermal emission
    - Is the rapid acceleration found in RXJ1713.7-3946 common?



Using IXO/WFI+HXI, we can do!

SNR Science

3. Systematic Study of X-ray Emission from SNRs

We have observed relatively bright (nearby) SNRs so far.

- We do not know X-ray properties of faint (distant) SNRs well.

  - The ASCA galactic plane survey and the Suzaku observations found

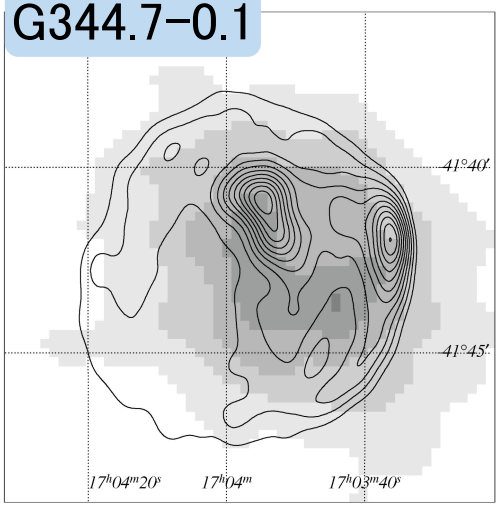
    1. middle-aged SNRs with strong emission lines from highly ionized metals.

    2. new extended X-ray sources (=SNR candidates) with low radio-surface brightness.

In this talk, I focus on these topics.

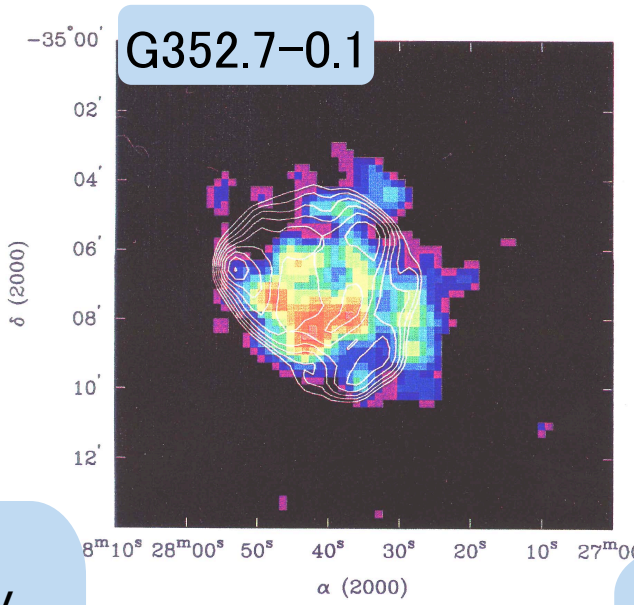
3-1 Middle-aged SNRs with Strong Emission Lines

G344.7-0.1



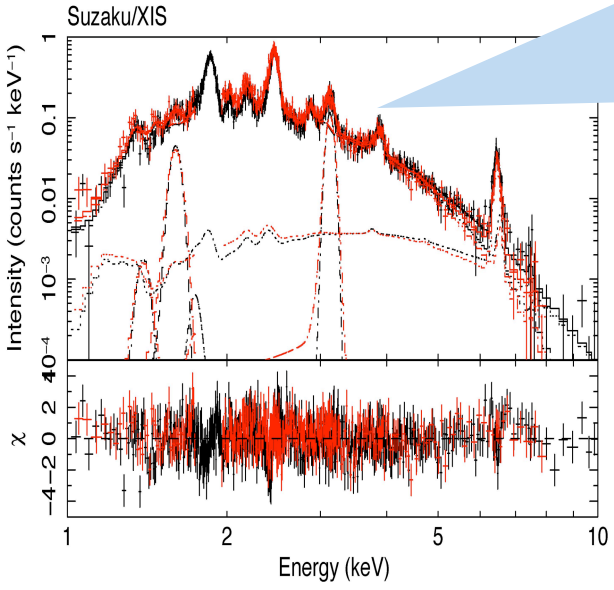
d~14kpc
Size~33pc
Middle-aged SNR

G352.7-0.1



d~8.5kpc??
Size~15pc??
Middle-aged SNR??

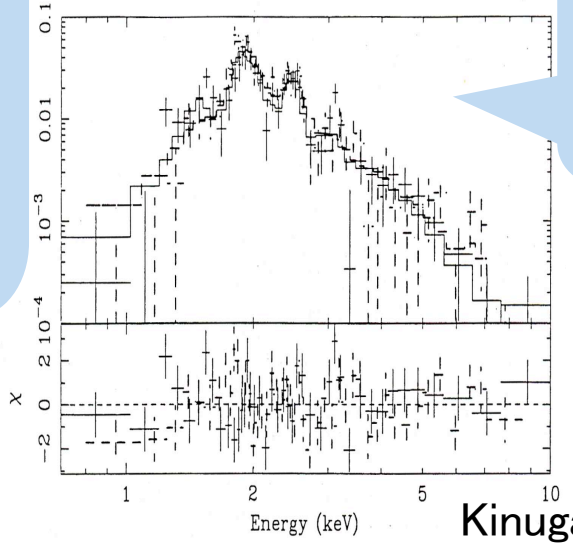
G344.7-0.1



Suzaku
kT~1keV
Si~1.6Solar
S~2.6Solar
Ca~3 Solar

Fe 6.465keV

Yamauchi et al. (2005), (2009)



ASCA
kT~2keV
Si~3.7Solar
S~3.4 Solar

Kinugasa et al. (1998)

3-1 Middle-aged SNRs with Strong Emission Lines

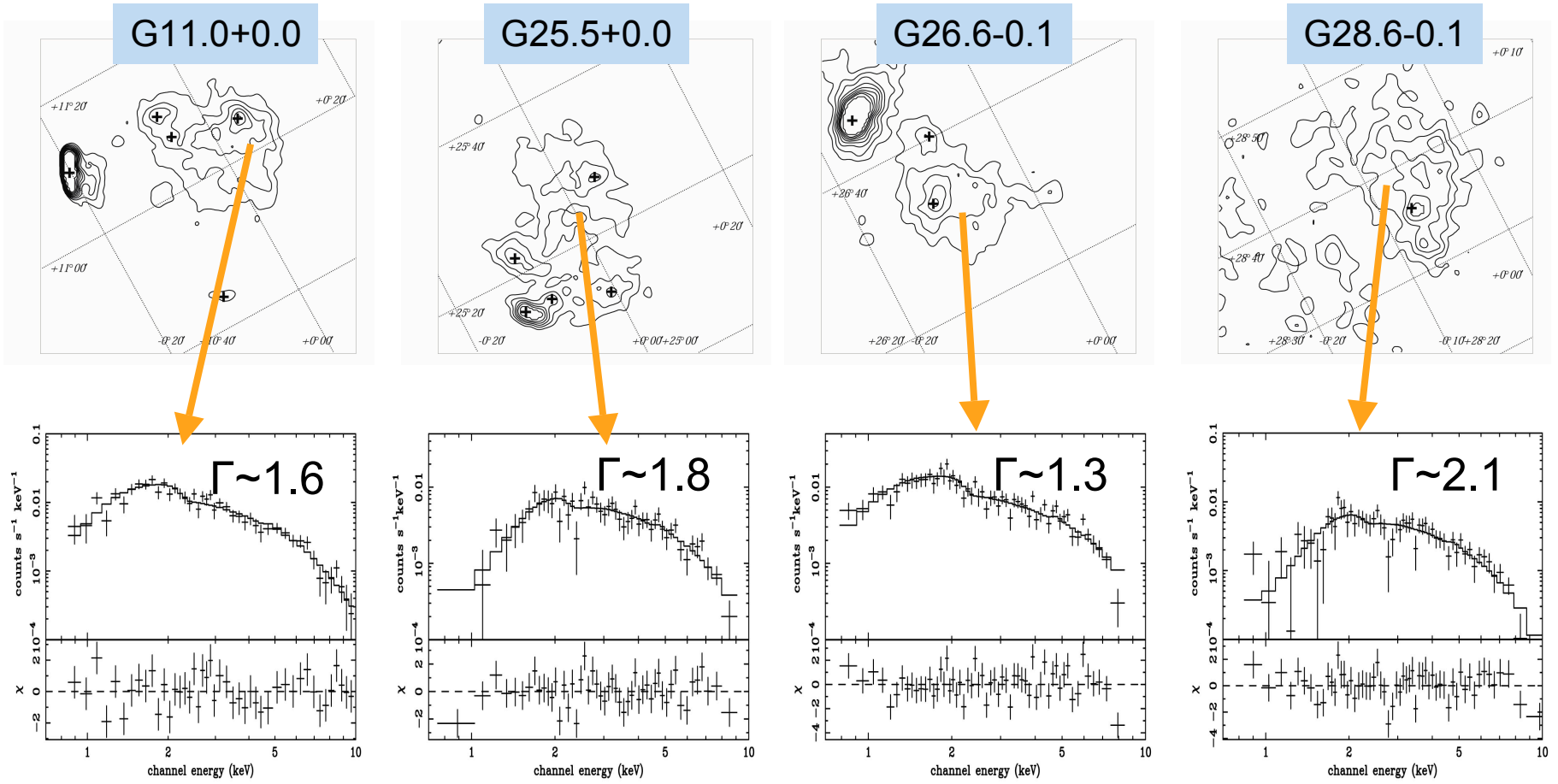
- G344.7-0.1 and G352.7-0.1 have not been detected in the X-ray band before the ASCA survey. (due to large N_H!)
- X-ray emitting matter of middle-aged and evolved SNRs mainly consists of the circumstellar matter swept up by the shock wave.
- If so, they are in the metal enhanced region in the Galaxy.
  - New SNR candidates in the GC region discovered with Suzaku exhibit overabundance (Nobukawa et al. 2008, Tsuru et al. 2009, ···).

Systematic study of the middle-aged and evolved SNRs provides metal distribution in the Galaxy using X-ray data.

Using IXO, we can obtain statistically good X-ray spectra of not only nearby bright SNRs but also distant faint SNRs.

3-2 New Extended X-ray Sources: SNR candidates

The ASCA survey discovered SNR candidates in the Galactic plane.

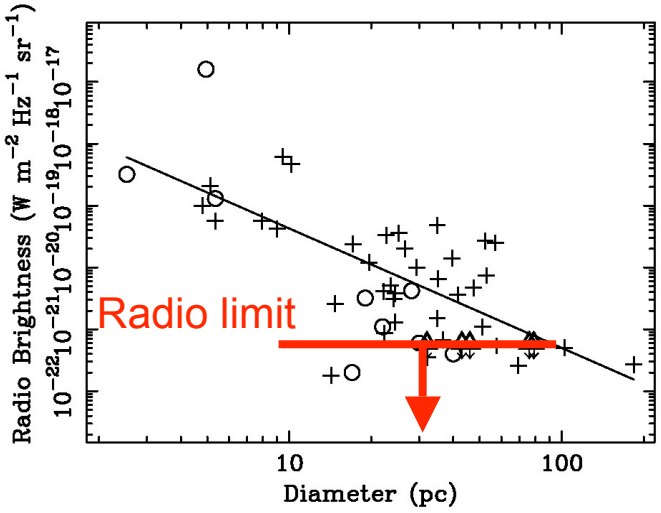


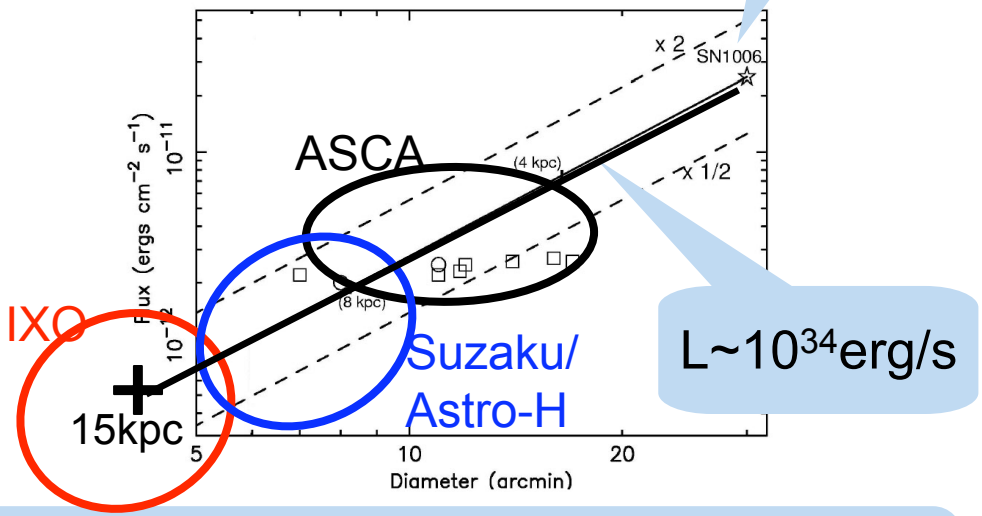
Bamba et al. (2001), (2003), Yamaguchi et al. (2004), Ueno et al. (2005)

3-2 New Extended X-ray Sources: SNR candidates

- Many SNRs would be hidden in the Galactic plane.
  - L~10^{34}erg/s, low radio brightness (below the detection limit)

・Are they SN 1006-like SNRs?
→ *Can they explain the total flux of the cosmic-ray?*
・How many SNRs are there in the Galaxy?
→ *How much energy did SNe input to the Galaxy in total?*





Using IXO/WFI+HXI, we can discover many SN1006-like SNRs in the Galaxy and we can determine their structure and spectral shape.

Summary

- Supernovae and supernova remnants are main suppliers of energy, heavy elements, and cosmic rays.

- In order to understand physics of SNRs,
  - measurements of emission lines in the plasma gas with IXO/XMS
  - observations of images and spectra of non-thermal emission with IXO/WFI+HXI
  - systematic study of X-ray emission from SNRs with IXO

  are important.

New type of X-ray sources will be discovered.